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Complexity and repeated implementation ☆

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Abstract

This paper examines the problem of repeatedly implementing an efficient social choice function when the agents' preferences evolve randomly. We show that the freedom to set different mechanisms at different histories can give the planner an additional leverage to deter undesirable behavior even if the mechanisms are restricted to be simple and finite. Specifically, we construct a history-dependent sequence of simple mechanisms such that, with minor qualifications, every pure subgame perfect equilibrium delivers the correct social choice at every history, while every mixed equilibrium is strictly Pareto-dominated. More importantly, when faced with agents with a preference for less complex strategies at the margin, the (efficient) social choice function can be repeatedly implemented in subgame perfect equilibrium in pure or mixed strategies. Our results demonstrate a positive role for complexity considerations in mechanism design.

JEL classification: A13; C72; C73; D02; D70

Keywords: Complexity; Repeated implementation; Efficiency; Finite mechanisms; Mixed strategies; Subgame perfect equilibrium

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1. Introduction

The success of a society often hinges on the design of its institutions, from markets to voting. From a game-theoretic perspective, the basic requirement of an institution is that it admits an equilibrium satisfying properties that the society deems desirable, as forwarded by the literature on mechanism design. A more satisfactory way of designing an institution is to have all of its equilibria to be desirable, or to achieve *full* implementation.

In a recent paper, Lee and Sabourian (2011a) (henceforth, LS) extend the scope of implementation to infinitely repeated environments in which the agents' preferences evolve stochastically, and demonstrate a fundamental difference between the problems of one-shot and repeated implementation. In particular, they establish, with minor qualifications, that in complete information environments a social choice function is repeatedly implementable in Nash equilibrium if and only if it is efficient, thereby dispensing with Maskin monotonicity (Maskin, 1999) that occupies the critical position in one-shot implementation and yet often amounts to a very restrictive requirement, incompatible with many desirable normative properties including efficiency (e.g. Mueller and Satterthwaite, 1977; Saijo, 1987). The notion of efficiency represents the basic goal of an economic system and therefore the sufficiency results in LS offer strong implications.

Despite the appeal of its results, the full implementation approach has often been criticized for employing abstract institutions that neither square up to the demands of real world mechanism design, nor are theoretically appealing. The implementation literature has therefore engaged in multiple debates as to whether it can maintain the high standards of its theoretical objective without exposing its key results to hinge on these issues (see, for instance, the surveys of Moore, 1992; Jackson, 2001; Maskin and Sjöström, 2002, and Serrano, 2004). The purpose of this paper is to bring the repeated analysis of LS to the realm of these debates. We adopt a novel approach that appeals to bounded rationality of agents and seek also to gain insights into a broader motivating enquiry: can a small departure from fully rational behavior on the part of individuals work in the favor of the society to broaden the scope of implementability? Specifically, we pursue the implications of agents who have a preference for less complex strategies (at the margin) on the mechanism designer's ability to discourage undesired equilibrium outcomes.[1]

Many strong implementation results (including those of LS) have been obtained through the usage of unbounded integer games which rule out certain undesired outcomes via an infinite chain of dominated actions. One response in the implementation literature, both in one-shot and repeated setups, to the criticism of its constructive arguments is that the point of using abstract mechanisms is to demonstrate what can possibly be implemented in most general environments; in specific situations, more appealing constructions may also work. According to this view, the constructions allow us to show how tight the necessary conditions for implementation are. Another response in the one-shot literature has been to restrict attention to more realistic, *finite* mechanisms. However, using a finite mechanism such as the modulo game to achieve Nash implementation brings an important drawback: unwanted *mixed* strategy equilibria. This could be particularly problematic in one-shot settings since, as Jackson (1992) has shown, a finite mechanism that Nash implements a social choice function could invite unwanted mixed equilibria that strictly Pareto dominate the desired outcomes.

In this paper, we apply our bounded rationality approach to the issue of implementing efficient social choice functions in a repeated environment with only simple mechanisms. In order to

[1] The complexity cost in our analysis is concerned with implementation of a strategy. The players are assumed to have full computational capacity to derive best responses.